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The role of mindfulness and mobile apps in managing stress and anxiety in children with ADHD

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**Abstract.** Attention-deficit/hyperactivity disorder (ADHD) is a neurodevelopmental condition affecting millions of children globally, characterized by persistent patterns of inattention and/or hyperactivity-impulsivity. Beyond these core symptoms, children with ADHD frequently experience heightened levels of stress and anxiety. These emotional challenges can stem from difficulties in self-regulation, academic pressures, social interactions, and the general demands of daily life. The co-occurrence of anxiety disorders in children with ADHD is also significant, further underscoring the need for effective strategies to manage these intertwined difficulties.In recent years, two promising avenues have emerged for addressing stress and anxiety in this population: mindfulness-based interventions (MBIs)and the increasing accessibility of digital technology, particularly mobile applications. This article explores the synergistic potential of integrating mindfulness practices with mobile health (mHealth) apps to provide children with ADHD with accessible, engaging, and effective tools for managing their stress and anxiety.

**Keywords:** Attention Deficit Hyperactivity Disorder (ADHD), Mindfulness, Mobile Apps, Stress, Anxiety

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**Introduction**

*Understanding the Interplay: ADHD, Stress, and Anxiety*

Attention-deficit/hyperactivity disorder (ADHD) is a chronic neurobehavioral disorder that primarily manifests in childhood, characterized by symptoms of inattention, hyperactivity, and impulsivity. These symptoms impair cognitive processing, attention, motor planning, and other behavioral functions. ADHD also often coexists with emotional dysregulation and various psychiatric disorders, including mood and anxiety disorders. It is estimated that up to 80% of individuals with ADHD experience at least one co-occurring psychiatric condition, most commonly depression and anxiety disorders, which complicate treatment and further impact quality of life (Biederman & Faraone, 2005).It is estimated that about 3% -7%of school-age children have diagnosed with ADHD. More specifically, concerning children with ADHD, they claim that these children tendto controltheir hyperactivity when they are occupied with motivating games, provided that they are not highly demanding in working memory (Alexopoulou, Batsou, & Drigas, 2019).

The disorder affects around 5-8% of the general population, with higher prevalence rates in boys compared to girls. ADHD frequently coexists with learning difficulties such as dyslexia, dysgraphia, and dyscalculia, and it is associated with significant academic and emotional challenges, including poor school performance, frustration, and aggressive behavior (Pliszka, 2003). In diagnosing ADHD, tools like the DSM-5, Conners ADHD Scale, and Wender Utan Rating Scale are commonly used, and interdisciplinary collaboration is emphasized for effective intervention.

Mindfulness, an approach focusing on present-moment attention, has gained recognition as an effective complementary treatment for ADHD, particularly for addressing emotional dysregulation and anxiety (Zylowska, Ackerman, & Smalley, 2008). Recent advances in mobile technology have facilitated the integration of mindfulness practices into apps designed to reduce stress and anxiety in children with ADHD. This paper explores the role of mindfulness and mobile apps as effective strategies for managing ADHD-related stress and anxiety, highlighting their potential in supporting traditional treatments such as pharmacotherapy and behavioral therapy (Mettlera, Bloomb, & Heatha, 2023).

Children with ADHD often face a world that feels overwhelming. The most important deficits concern metacognition, which is responsible for self-control and awareness abilities (Mitsea, Drigas & Skianis, 2022).Their inherent challenges with attention, impulse control, and executive functions can lead to academic struggles, social misunderstandings, and difficulties navigating daily routines (Barkley, 2021).Theseexperiences can contribute significantly to feelings of stress, frustration, and anxiety. Furthermore, the very nature of ADHD can make emotional regulation more challenging, leading to more intense and prolonged emotional responses to stressors (Drigas & Mitsea, 2020). As the provided text highlights, a significant percentage of individuals with ADHD also have coexisting anxiety disorders (Păsărelu et al., 2020), creating a complex clinical picture that necessitates comprehensive and multifaceted approaches to intervention.

Children with ADHD often face significant challenges in various aspects of daily life, including their social relationships, academic performance, and self-esteem. These children may struggle with tasks that require audiovisual and verbal memory, vigilance, inhibition control, and planning (Willcutt, Nigg, Pennington, & Rohde, 2005). They also experience difficulties with gross and fine motor coordination, sequencing movements, working memory, and regulating emotions (Barkley, 2006). Moreover, ADHD can impact language and speech development, as well as time processing and information timing, leading to frustration, poor academic achievement, and difficulties in forming and maintaining relationships (Sonuga-Barke, Castellanos, & Russell, 2003).

In educational settings, the integration of Information and Communication Technologies (ICTs) has shown promise in supporting children with ADHD. ICT tools can promote interactivity and self-directed learning, which help develop and enhance cognitive and metacognitive skills. These include attention, concentration, memory, self-regulation, creativity, flexibility, and critical thinking—skills essential for cognitive development (Melnyk, Feinstein, & Alpert-Gillis, 2010). The use of mobile apps and artificial intelligence (AI) also plays a crucial role in the early detection of ADHD in preschool children, offering innovative ways to assess and address the needs of children with ADHD while fostering the growth of necessary cognitive skills (Biederman & Faraone, 2005; Zylowska, Ackerman, & Smalley, 2008).

*Mindfulness: Cultivating Present Moment Awareness*

Mindfulness, defined as paying attention to the present moment with non-judgmental awareness (Kabat-Zinn et al., 2003), has gained considerable traction as a valuable tool for improving mental well-being. For children, mindfulness practices can help cultivate self-awareness (Hölzel et al., 2011), enhance emotional regulation skills (Huguet et al., 2019), and promote a greater sense of calm amidst the often-chaotic internal and external experiences associated with ADHD. By learning to focus on their breath, bodily sensations, and passing thoughts without getting carried away by them (Tang et al., 2015), children can develop a greater capacity to observe and manage their emotional responses to stressful situations. Research has indicated that mindfulness training can positively impact attentional and behavioral regulation (Santonastaso et al., 2020; Zaccari et al., 2022), emotional regulation (Huguet et al., 2019), and even sleep quality.

In recent years, the concept of mindfulness has gained attention as a complementary practice for improving cognitive and emotional regulation. Kabat-Zinn et al. (2003) defined mindfulness as the awareness that arises from paying attention on purpose, in the present moment, and non-judgmentally. Vago et al. (2012) distinguished mindfulness as both a method for developing a skillset to reduce self-processing biases and a continuous attentional capacity called "mindful awareness." Mindfulness can be viewed either as a temporary state or as a dispositional trait, depending on whether it is momentary or a consistent pattern of cognition, emotion, or behavior.

Mindfulness practices involve orienting attention to the present moment and monitoring thoughts, sensations, and emotions in real-time (Tang et al., 2015). These practices aim to cultivate self-awareness, self-regulation, and improve relationships with oneself and others (Vago et al., 2018). Mindfulness training is often linked to key metacognitive components that contribute to a robust self-regulation system, including attention regulation, body awareness, emotion regulation, and a change in self-perspective (Hölzel et al., 2011).

Flavell, who introduced the term metacognition, defined it as the awareness of one's cognition and cognitive processes (Flavell, 1979). Metacognition contains consciousness and self-awareness, abilities that help individuals to perceivetheir inner and outside world (Drigas& Karyotaki, 2019). Metacognition includes both the ability to be aware of these cognitive processes and to manage them effectively (Fleur et al., 2021). Drigas and Mitsea (2020) offered a broader definition of metacognition as a set of meta-abilities and meta-skills applied consciously to achieve functional capability, self-efficacy, independent living, and life satisfaction. They emphasized that metacognition involves strategies and skills that help individuals observe, regulate, and adapt their internal cognitive processes, as well as the ability to distinguish between functional and dysfunctional cognitive states. This process is achieved through systematic training.

Also, Drigas and Tsakou (2025) explore the integration of mobile technologies, mindfulness, and metacognitive practices, emphasizing the role of parents in fostering these skills within schools and societies. Parents can enhance their children's development by utilizing mobile apps and digital tools that promote mindfulness and self-regulation. Additionally, the authors highlight the importance of parents' involvement in digital environments to support empathy, self-consciousness, and metacognitive growth, thereby contributing to the cultivation of these skills in future generations.

Metacognition is a key component of cognitive development, involving the ability to be aware of, control, and adjust one's internal cognitive processes. This includes recognizing the difference between productive and unproductive mental states, and consciously selecting mental states that maximize one's abilities and self-awareness. Through consistent practice, individuals can develop the ability to better manage their cognitive and emotional states, which leads to improved cognitive functioning and personal growth. Tools like mindfulness techniques and mobile applications can support this training, providing accessible methods to strengthen metacognitive abilities (Drigas &Tsakou, 2025).However, students with developed metacognitive strategies and self-awareness can develop memorization mechanisms, helping them toovercome their deficits(Pappas, Drigas, &Polychroni, 2018).

There has lately been emphasis on teaching methods and learning tools that help students develop metacognitiveskills, inorder to achieve higher levelof skills, asfor examplecritical thinkingand complexproblem solving, requiredin the 21st century. One of the teaching methods, based on real problem solving, while involving them in the learning progress via an experiential way, is this of STEM or STEAM learning. Via theintegration of science, technology, engineering, mathematicsand art, this method manages to develop student’s problem-solving skills, usingactivities inspiredby everyday life(Drigas, Mitsea& Mantas, 2021).

It seems that these soft skills are in line,with the 8 pillarsof metacognition, such as Self-Awareness, Self-Monitoring, Self-Regulation, Adaptation, Recognition, Discrimination, Mnemosyne and Consciousness. By training student’s metacognitive skills fromearly schoolage to early adolescence, studentscan improvetheir problem-solving strategies, self-regulation and math performance as well (Pappas, Drigas, &Polychroni, 2018).

The role of attention regulation in mindfulness is emphasized by studies showing its importance in mindfulness practices, including attentional orienting (curiosity, openness, acceptance), engaging attention, and sustaining attention (Lutz et al., 2008). Malinowski (2013) highlighted how mindfulness enhances inhibitory control, which may help improve impulsivity. Other studies emphasize mental flexibility, an important aspect of self-regulation (Moore & Malinowski, 2009).Several studies have investigated the effects of mindfulness interventions on children with ADHD. Santonastaso et al. (2020) found that an eight-week mindfulness meditation program significantly improved inhibition control, emotional regulation, and attentional control in children with ADHD. Zaccari et al. (2022) similarly reported that mindfulness meditation improved sleep quality and behavioral regulation in children with ADHD. Huguet et al. (2019) also observed improved emotional regulation in children with ADHD following mindfulness group intervention, which included techniques such as breathing meditation, body scans, and emotional awareness exercises.

These studies demonstrate the potential benefits of mindfulness interventions in helping children with ADHD improve key aspects of self-regulation, such as attention, inhibition, emotional control, and sleep quality.

*Mindfulness and the Management of Stress and Anxiety in Children with ADHD*

Mindfulness is the practice of paying attention to the present moment with an open, non-judgmental attitude, including techniques such as breathing, body scanning, and focusing on the present moment. For children with ADHD, mindfulness can enhance self-awareness and self-regulation, providing tools to better manage their emotions (Zylowska et al., 2008). The practice of these techniques has been shown to reduce anxiety symptoms and improve concentration and emotional stability (Van der Oord et al., 2012).

Benefits of Mindfulness for Children with ADHD:

1. Improved Emotional Regulation: Children with ADHD often experience emotional outbursts. Mindfulness helps them recognize their emotions and manage them before they escalate into anxiety or aggression (Jensen et al., 2016).
2. Reduced Impulsivity: Mindfulness enhances the child’s ability to remain calm and pause before reacting in stressful or anxiety-provoking situations (Zeidan et al., 2010).
3. Increased Focus: Regular mindfulness practice helps children improve their ability to stay focused and reduce distractions, which is a common challenge for children with ADHD (Zylowska et al., 2008).
4. Stress Reduction: Several studies have shown that mindfulness can reduce physical symptoms of anxiety, such as increased heart rate and muscle tension, offering a tool for relaxation (Khoury et al., 2013).

*The Role of Mobile Apps in Supporting Mindfulness for Children with ADHD*

Recent research has explored the integration of mindfulness practices, Internet of Things (IoT) technologies, and assistive devices to manage stress in children with learning disabilities and Attention- Deficit/ Hyperactivity Disorder (ADHD). Certain studies highlight the potential of combining mindfulness techniques with IoT-enabled devices to enhance stress management and overall well-being in these populations.

A study by Moraiti, Fotoglou, and Drigas (2023) examined the effects of mindfulness training on adults with ADHD and depressive symptoms, emphasizing the role of digital technologies in delivering mindfulness interventions. Moraiti et al. (2022) discussed the benefits of assistive technologies, including IoT applications, for individuals with ADHD, highlighting how these tools support stress management and daily functioning.

Furthermore, research by Moraitiet al. (2022) explored the impact of IoT on the education and health promotion of students in special schools, noting improvements in functionality and mental health among children with motor and mental disabilities. Doulou, Drigas and Skianis (2023) highlighted the advantages of virtual reality in delivering metacognitive training techniques, including mindfulness and breathing exercises, to improve cognitive and emotional outcomes in children with learning disabilities and ADHD.

In fact, technology offers new possibilities for integrating mindfulness into children’s lives through specialized mobile apps, which provide guided exercises, games, and interactive activities (Lomas et al., 2015). These apps are designed to be engaging and accessible for children, helping those with ADHD manage their emotions and behavior in daily basis.

*Benefits of Using Mobile Apps for Mindfulness*

There is an increasing number of mobile apps available for adolescents with mental health problems that assimilate mobile health into mental health services.Study reveal results in which the installation of a specific application in a mobile phone provides a cognitive behavioral therapy intervention for the treatment of symptoms of anxiety and depression.Researchers have systematically searched for relevant mental health apps,focusing on depression, bipolar disorder, anxiety disorders, self-harm, suicide prevention, conduct disorder, eating disorders and body image issues, schizophrenia, psychosis, and insomnia) for mobile devices for use by adolescents younger than 18 years(Stathopoulou et al., 2019).

WHAAM (WA) is a Web Health Application for ADHD Monitoring, accessible through both the web (PCs) and mobile devices. It is based on the concepts and methods of functional behavioural assessment (FBA). This network monitors the dysfunctional behaviors of the child at school and at home and provides information about the diagnosis, specific medication and schools that are suitable for the child. Children and adults with ADHD tend to be more focused and concentrated when engaged in digital activities, especially gaming. Another study explored three fields in which computer games and tests concerning ADHD focus: human activity in daily situations, education, and medical practice. Most existing software targets executive functions with the aim of improving them. Throughout their study, researchers determined that frequent gamers exhibit better cognitive functions compared to infrequent or non-gamers. New games based on tasks involving monitoring and improving both attention and inhibitory activity have shown promise (Alexopoulou, Batsou, & Drigas, 2019).

Virtual reality (VR) is increasingly being used in education as a tool for cognitive training and inquiry-based learning, while also serving as an intervention tool for psychiatric disorders such as depression, anxiety, and phobias. VR applications are gaining attention as promising interventions for students with neurodevelopmental disorders, physical disabilities, and learning difficulties. Other studies have revealed improvements in metacognitive skills, such as self-observation, attentional flexibility, inhibitory control, and other executive functions. Several studies highlight VR's role in emotional regulation for various mental and behavioral disorders, including severe anxiety, phobias, and depression.

Virtual environments provide well-controlled sensory stimuli tailored to users' needs, as children with learning disabilities often struggle with sensory processing deficits. VR enables the creation of highly interactive 3D environments involving multi-sensory channels (vision, audition, haptics), allowing the brain to respond as it would in real-life situations. VR leverages attention as a rehabilitation tool. The ability to direct attention is a key feature of VR, distinguishing it from other technologies. Attention plays a regulatory role and is crucial for behavior modification. VR can either distract users from stressful stimuli or redirect their attention appropriately.

Yüksel et al. (2020) evaluated the efficacy of VR breathing training for anxiety and sleep disorders in high-school adolescents. Twenty-nine teenagers with sleep problems engaged in slow diaphragmatic breathing while passively viewing a relaxing immersive VR environment designed to foster cognitive relaxation and distraction. The VR breathing intervention increased relaxation and reduced worry. Heart rate decreased, and sleep efficiency improved. The authors concluded that VR technology enhanced overall sleep quality in adolescents with sleep-related issues.

The intervention also improved internal control, self-monitoring skills, and intrinsic motivation. Participants developed greater awareness of their physiological and neuropsychological states. Additionally, VR breathing facilitated coordination between respiration and attention, leading to physiological regulation and metacognitive improvements (Hamasaki, 2020).

Virtual reality employs various metacognitive techniques, cultivating meta-abilities and meta-skills such as self-observation, self-regulation, and adaptation.

In a pilot study with 86 children, researchers assessed the efficacy of DEEP, a virtual reality biofeedback video game that provided deep breathing training in an immersive, relaxing environment without explicit tasks or goals. DEEP also incorporated mild exposure to stressful situations (e.g., dark caves) to enhance self-regulation skills. Slow, deep breathing allowed players to progress in the game. Results showed that DEEP improved internal control, engagement, and attention levels (Mitsea, Drigas, & Skianis, 2022).

Sra, Xu, and Maes (2018) explored the effectiveness of using breathing actions as input in VR games. Participants reported a stronger sense of presence when using breathing controls during gameplay. These findings suggest that breathing control practices enhance present-moment attention. The researchers also developed and evaluated a VR-based respiratory biofeedback game to promote diaphragmatic breathing (Mitsea, Drigas, & Skianis, 2022).

In another study, researchers examined the effectiveness of slow breathing in a virtual environment to reduce alertness in 29 adolescents. Results indicated that VR-based slow breathing enhanced cognitive relaxation, reduced distraction, regulated heart rate variability, and decreased vigilance. These findings suggest that VR-based breathing training can improve attention span.

*Virtual Reality and Metacognition Training Techniques for Learning Disabilities*

1. Ease of Use and Engagement: Many mobile apps are designed to be easy to use and enjoyable for children, with characters and games that encourage them to practice mindfulness (Mitchell et al., 2013).
2. Consistency and Routine: Mobile apps allow children to track their progress and incorporate mindfulness into their daily routines through reminders and structured activities (Kuyken et al., 2013).
3. Variety of Techniques: Mobile apps typically offer a range of mindfulness techniques, including breathing exercises, guided meditations, and body scans, allowing children to find the methods that work best for them (Hölzel et al., 2011).
4. Parental Involvement: Some apps provide tools for parents to monitor their child’s progress and even engage in mindfulness practices together, fostering collaboration and support at home (Singh et al., 2012).

*Examples of Mobile Apps for Mindfulness and Stress Reduction in Children with ADHD*

1. Headspace for Kids: This app offers age-appropriate guided meditations and mindfulness exercises aimed at improving focus and emotional regulation (Harris, 2019).
2. Calm Kids: Calm offers a special section for kids, providing relaxation techniques, breathing exercises, and sleep stories designed to reduce anxiety and help children unwind (Harris, 2019).
3. Smiling Mind: Smiling Mind offers programs specifically designed for children and adolescents with ADHD, integrating mindfulness and emotional regulation techniques into fun, engaging lessons (Mitchell et al., 2013).
4. Breathe: This app includes guided meditation and mindfulness exercises, featuring mindfulness-based stress reduction (MBSR) programs for children and parents to enhance overall well-being (Hölzel et al., 2011).

*Key Features of Mindfulness Mobile Apps for ADHD Stress Management:*

Mindfulness apps tailored for children often incorporate features designed to enhance engagement and cater to their specific needs:

* **Safe and Controllable Environment:** Apps provide a predictable and non-threatening space to practice mindfulness exercises (Jensen et al., 2016).
* **Focus on the Present Moment:** Guided meditations and activities encourage children to anchor their attention in the here and now (Zeidan et al., 2010).
* **Embodiment through Visualization:** Apps often use imagery to help children connect with their physical sensations and emotions (Kabat-Zinn, 2003; Hölzel et al., 2011).
* **Experiential Learning:** Interactive exercises make learning coping strategies fun and engaging (Miller et al., 2013).
* **Attentional Focus Training:** Features like sound cues and gentle reminders help redirect attention and minimize distractions (Zeidan et al., 2010).
* **Multisensory Experiences:** Some apps utilize visual, auditory, and even tactile elements to deepen the mindfulness experience (Habak et al., 2021).

*Applications of Mindfulness Mobile Apps in Managing ADHD-Related Stress and Anxiety:*

The integration of mindfulness into mobile apps offers various practical applications for children with ADHD:

* **Direct Stress and Anxiety Management:** Apps provide specific exercises and techniques to help children cope with immediate feelings of stress and anxiety (Jensen, et al., 2016).
* **Development of Coping Strategies:** Children can learn and practice strategies for managing frustration, impulsivity, and anxiety in a safe digital environment (Zylowska et al., 2008).
* **Emotional Regulation Training:** Guided practices help children become more aware of their emotions and develop skills to regulate them effectively (Hölzel et al., 2011).
* **Improved Attention and Focus:** Mindfulness exercises within apps can help children practice sustained attention and reduce distractibility (Zeidan et al., 2010).
* **Progress Monitoring and Motivation:** Tracking features can empower children to see the benefits of their practice and stay motivated (Michela et al., 2021).

**Conclusion: Embracing a Digital Path to Calm**

Mindfulness mobile apps represent a significant advancement in providing accessible and engaging support for children with ADHD struggling with stress and anxiety. By offering a safe, structured, and often gamified environment, these apps can effectively deliver mindfulness techniques that promote self-awareness, emotional regulation, and improved focus. As technology continues to evolve, the integration of MBIs with mHealth applications holds immense potential to empower children with ADHD to develop essential coping skills and enhance their overall well-being. Further research into the efficacy and optimal design of these tailored digital interventions is crucial to fully harness their potential and ensure they meet the unique needs of this population. Ultimately, the combination of ancient wisdom from mindfulness practices and the innovative reach of mobile technology offers a promising path towards fostering greater calm and resilience in the lives of children with ADHD.

Mindfulness and mobile apps provide valuable tools for managing stress and anxiety in children with ADHD. These tools can help children develop better emotional regulation, reduce impulsivity, and improve focus. When used in conjunction with other ADHD management strategies, mindfulness can support overall well-being and improve quality of life for children with ADHD. With the rise of accessible mobile apps, mindfulness practices can now be more easily integrated into daily routines, making them an important resource for both children and their families.

The use of mobile applications and mindfulness strategies for stress management in children with Attention-Deficit/Hyperactivity Disorder (ADHD) has emerged as an effective approach. These apps provide a safe, relaxing, and predictable environment, helping children focus on the present moment and develop emotional regulation and concentration skills. The integration of visualizations, sounds, and interactive activities enhances the experience, while the mindfulness approach allows children to recognize and manage their emotions and thoughts.

Specifically, these apps assist in reducing anxiety and stress, enhancing the ability of children with ADHD to focus, manage attention, and regulate emotional responses. Through features such as progress tracking and gamification, children are motivated to remain engaged with mindfulness exercises. These tools have been shown to be particularly beneficial for improving emotional regulation and attention control, offering a comprehensive approach to ADHD management (Zylowska et al., 2008; Zeidan et al., 2010).

Mindfulness-based techniques help children practice sustained attention and reduce distractions, which are common challenges in ADHD, while also fostering relaxation through visualization exercises. Additionally, apps provide valuable feedback on progress, helping both children and caregivers monitor emotional well-being improvements over time (Michela et al., 2021).

These mobile mindfulness applications represent a promising tool in supporting ADHD children by providing accessible, engaging, and personalized interventions that target stress management, emotional regulation, and attention improvement.

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